



# ***Electromagnetic Environmental Effects (E<sup>3</sup>)***

---

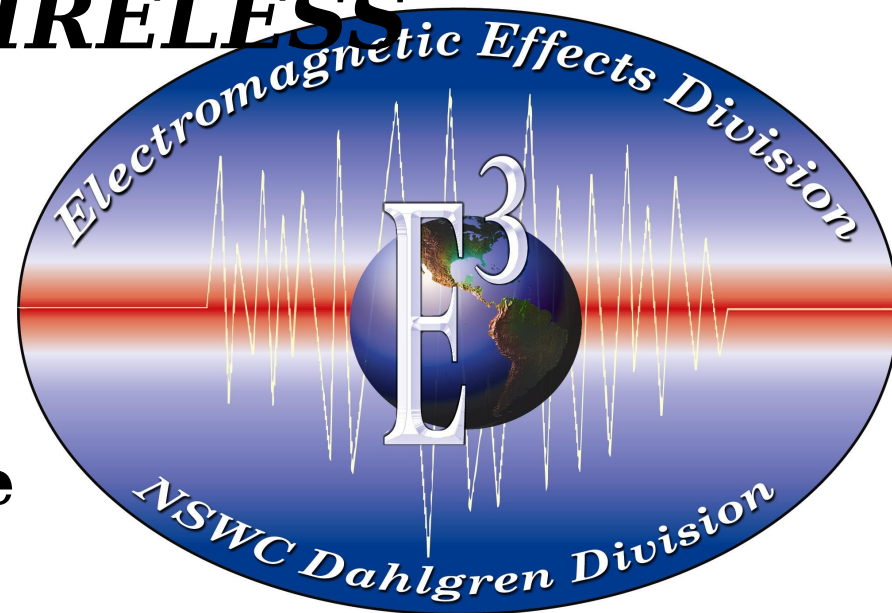
## ***E<sup>3</sup> AND SPECTRUM MANAGEMENT CONCERNS FOR WIRELESS TECHNOLOGIES***

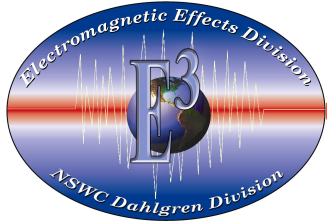
**Navy Wireless Networks  
Summit II**

**Defense Logistics Agency  
Town & Country Conference  
Center San Diego, CA**

***17-19 August 2004***

***Naval Surface Warfare Center, Dahlgren  
Division (NSWCDD)  
(540) 653-5660***

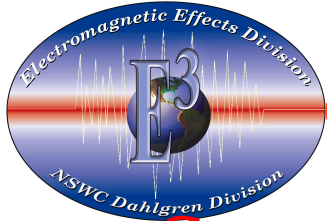




# Objective

---

- **E<sup>3</sup> and Spectrum Management (SM) challenges of wireless technology proliferation**
- **DoD wireless E<sup>3</sup> efforts to date (Navy perspective)**
- **NSWCDD J50 E<sup>3</sup>/SM Recommendations**



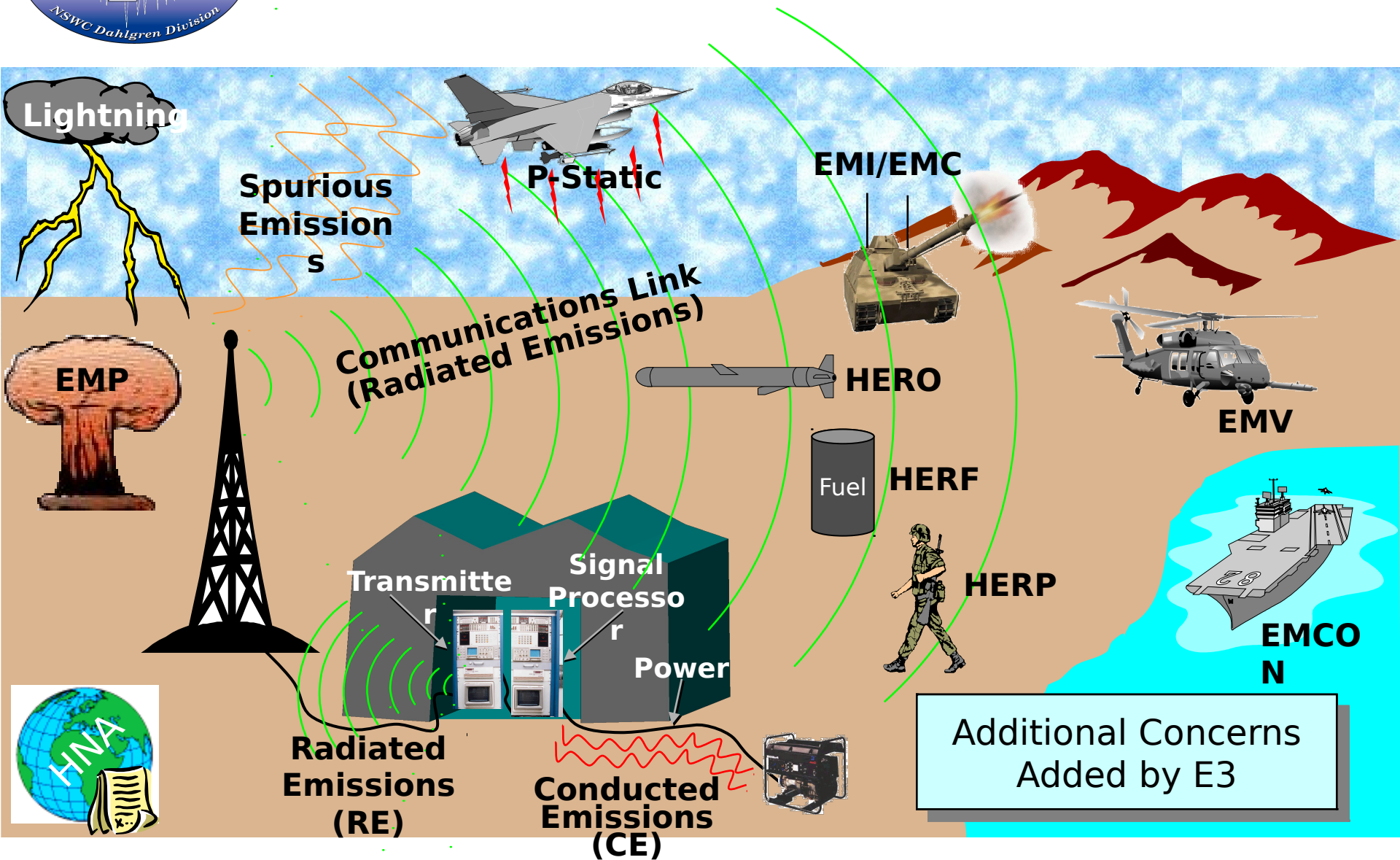
# **E<sup>3</sup> and SM Technical Areas**

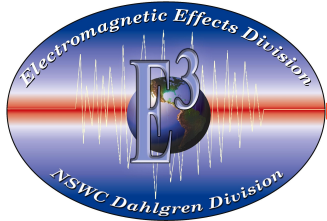
---

- Spectrum Certification/Allocation
- Conducted & Radiated Emissions
- Conducted & Radiated Susceptibility
- **HERO**/HERF/HERP
- ESD
- Precipitation static
- Lightning
- Electromagnetic Pulse (EMP)
- **Wireless Communication Performance**



# E<sup>3</sup>/SM Mission Assurance





# NSWCDD Relationship to the DoD and Wireless Communities

## DoD Support/Interaction

**Joint Spectrum  
Center**

**TRISYS COM**

**NAVSEA 62E**

**NAVSEA 04L514**

**Naval Ordnance  
Safety and  
Security Activity**

**Office of Naval  
Research**



## Wireless E<sup>3</sup>/SM

**Joint Participation  
Commanders Group**

**DoD AIT IPT**

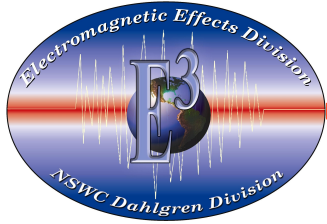
**DoD RFID IPT**

**Naval Integrated  
Information  
Networks**

**Navy WLAN IPT**

**Army Ammunition  
Logistics and  
Integration Agency**

**Various Standards**



# **E / SM Concerns of Wireless Technology Proliferation**

**Spectrum certification/allocation**  
**Off-board detectability (EMCON)**

NSWCDD J50 has  
ongoing applied  
expertise

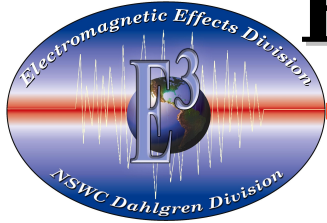
**EM Environment Levels (HERO/HERP/HERF)**

**Interference from other EM sources**

**Interference to existing equipment**

**Wireless communication performance**

NSWCDD J5  
R&D



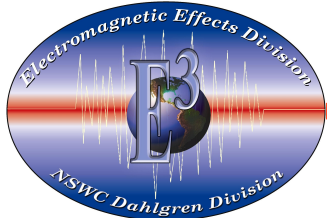
# Example Navy Spectrum Issues

---

- Potential for Automatic Identification Technology (AIT) Interference with Navy Radars
  - 433 MHz
    - AN/SPS-40E shipboard
    - Airborne radars
  - 902 and 915 MHz
    - AN/SPS-49(V)1 thru (V)9 shipboard
    - AN/SPS-49A(V)1 shipboard
- AN/SPS-40E installed on 38 U.S. Navy and Coast Guard vessels.
  - Also installed on 50+ Foreign ships.
- AN/SPS-49 installed on 93 U.S. Navy Ships.
  - Also installed on 50+ Foreign ships.

# **Current Wireless E<sup>3</sup>/SM Requirements**

---



- **Spectrum Certification/Allocation**

- DD Form 1494
- Host nation agreements

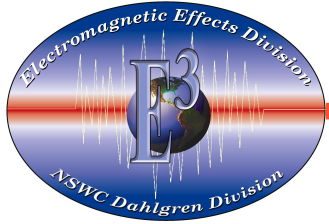
- **Conducted and Radiated Emissions and Susceptibility**

- MIL STD 464
- MIL STD 461
- FCC part 15 (COTS; emissions only)

- **HERO**

- MIL STD 464
- NAVSEAINST 8020.7D
- NAVSEA OP 3565
- NAVSEA OP 4
- NAVSEA OP 5

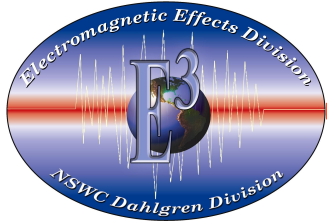




# **E<sup>3</sup>/SM Measures Currently Implemented**

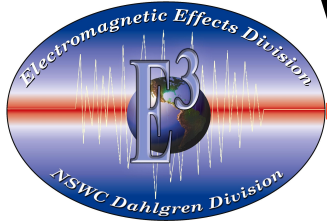
---

- **DD Form 1494**
- **FCC Tests**
  - **conducted and radiated emissions only**
  - **typically not worst-case exercising**
  - **insufficient for some DoD platforms, e.g., Navy ships**
- **HERO**
- **Communication Performance**



# Examples of Equipment Certification List

<b>Unit Nomenclature</b>	<b>RF Transmit Power (mW)</b>	<b>Transmit Frequen cy (MHz)</b>	<b>Safe Distance (inches/fe et)</b>
<b>SaviReader 410R</b>	<b>2.29</b>	<b>433.92</b>	<b>4.4/0.4</b>
<b>Savi Gate Reader 410R</b>	<b>2.3</b>	<b>433</b>	<b>4.4/0.4</b>
<b>Savi Gate Reader 410R-201</b>	<b>300</b>	<b>902</b>	<b>24.0/2.0</b>
<b>Savi Mobile Reader 410R-202</b>	<b>100</b>	<b>2400</b>	<b>5.0/0.4</b>
<b>RF Model (Utilicom)</b>	<b>500</b>	<b>2400</b>	<b>12.0/1.0</b>



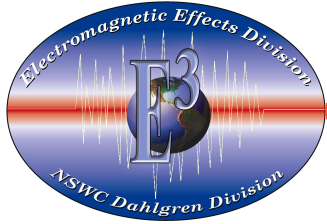
# What Needs Improvement?

---

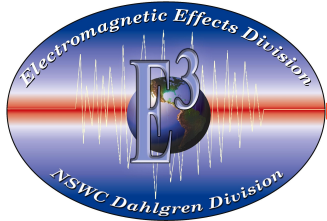
- **E<sup>3</sup>/SM involvement early in development/acquisition programs**
- **Wireless community awareness of in-service configurations and EM Environments (EMEs)**
  - Near-touching proximity
  - Complex cavities
  - Other transmitters (some high-powered)
- **Wireless community understanding of device performance bounds (actual vs product spec sheets)**
- **Tailored MIL-STD-461 and 464 testing for wireless technologies to be used on DoD platforms**
- **Plan/provide for lifecycle E<sup>3</sup>/SM**
- **E<sup>3</sup> research to**
  - reduce test time/cost
  - predict field levels and communication performance

# Electromagnetic Environments (EMEs)

---



- **Conducted EME**
- **Radiated EME**
  - **Near-touching proximity (near fields)**
  - **Complex cavity effects**
    - **Cumulative power from simultaneous transmission**
    - **Affects volumetric ambient field levels**
    - **Separation distance loses meaning**
    - **Potential susceptibility impact to co-located equipment**
    - **Potential wireless communication performance impact**
  - **Other transmitters**
    - **Some DoD EMEs are harsh, e.g., Navy shipboard**
    - **Wireless devices are generally not tested for radiated susceptibility**

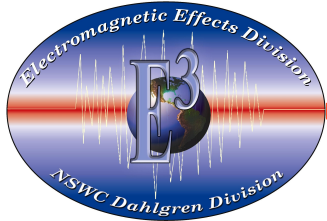


# Example Of Where Complex Cavity Effects Can Matter

---

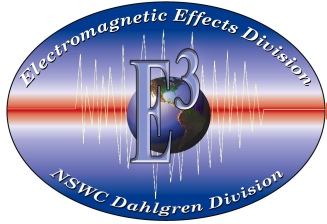


# Wireless Device Performance Bounds



- **Variety of modulation schemes, output powers, and communication protocols**
  - Can impact potential interference (e.g., time scale of field effect can impact device upset)
- **Max power output configuration**
  - User adjustable
  - System-dynamic
  - 'worst' case sometimes not obvious
  - Unit-to-unit and lot-to-lot variations
- **Radiated Emissions (RE) Test Impact**
  - Need worst case (max power output) configuration
  - Typical tests may be insufficient
  - Analyses using only manufacturer data sheets can be insufficient

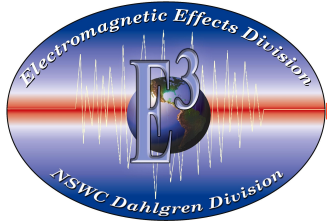
***How devices are exercised matters!***



# Summary

---

- **E<sup>3</sup> and Spectrum Management (SM) challenges of wireless technology proliferation**
- **DoD wireless E<sup>3</sup> efforts to date (Navy perspective)**
- **NSWCDD J50 E<sup>3</sup>/SM Recommendations**



# Questions

---

**NAVSEA 62E/04L / NOSSA / NSWCDD  
POC on E<sup>3</sup>/SM for Wireless  
Technologies:**

**NSWCDD**

**DSN 249-3452, (540) 653-3452**

